SkyWater

A young woman pauses while hiking across land traversed long ago by her Paiute ancestors in an area north of what is now called Gerlach, Nevada. Though surrounded by acres of wetlands and dozens of natural spring-water pools, she is thirsty. As she scans the landscape of subtle browns and tans, she catches a ray of sunlight reflected off of a tall, bronze, leaflike object in the distance. “Pangadu Paa’a” (SkyWater) she whispers to herself as she smiles and heads in that direction.

Water has always been our planet’s most indispensable natural resource, endowed with special, seemingly magical powers of physical transformation derived from its unique molecular properties and extraordinary role in Earth's geological and biological processes. As we move into the 3rd decade of the 21st century, humanitarian crises, epidemic disease, destabilizing violence, and corrupt, failed states are spreading to areas that perhaps had previously been able to ignore the chaos already rife in the most water-deprived regions of our planet, where 20 percent of humanity lacks access to sufficient clean freshwater for drinking and cooking and 40 percent don’t have enough for adequate sanitation. The news seems overwhelmingly dismal at times as humanity struggles to contend with the ultimate challenge: learning how to manage our crowded planet's resources in both an economically viable and an environmentally sustainable manner. And while some think that by building barriers and hoarding resources they can postpone the day of reckoning indefinitely, it is increasingly apparent to even those most dedicated to exploiting natural resources and exercising dominion over the natural world that, in the words of Adlai Stevenson:

“We travel together, passengers on a little space ship, dependent on its vulnerable reserves of air and soil; all committed for our safety to its security and peace; preserved from annihilation only by the care, the work, and, I will say, the love we give our fragile craft. We cannot maintain it half fortunate, half miserable, half confident, half despairing, half slave—to the ancient enemies of man—half free in a liberation of resources undreamed of until this day. No craft, no crew can travel safely with such vast contradictions. On their resolution depends the survival of us all.”

Over 4 billion people worldwide are currently facing severe water scarcity and, given water's inextricable, deep interdependencies with energy, food, and climate change, this number is likely to increase over time unless steps are taken now reduce or eliminate dependence on extractive practices. With the simple premise that clean water, drawn from the very air around us, can be freely and easily accessible to all the message of SkyWater is one of hope.

Making use of the water vapor that is present in the air even at low relative humidity levels, SkyWater collects water by absorbing this vapor in a desiccant material suspended in a hydrogel matrix. Then, in a second step, the vapor is desorbed at elevated temperatures followed by condensation of the hot water vapor. Water is taken up during the colder nighttime when the relative humidity is higher and desorbed during daytime. The necessary heat for desorption is provided by solar radiation, while the condensation occurs at ambient temperatures eliminating the need for power beyond

that provided by the glass solar tiles with nanotechnological coating that are integral to the unit.

Once collected, the water flows down from the leaf into the base, where trace minerals are added for flavor and then stored in a 600 liter food grade water barrel. Using data from experiments conducted in arid climates similar to northwestern Nevada, it is estimated that the device will produce as much as 9.5 liters per day (see footnotes) with no discernible effect on the environment (research shows that it would take thousands of water-collecting panels per person on earth to even begin to have an impact). Spread singly out along trails or arranged in groups to avoid shading each other, SkyWater provides life-giving, safe, potable water without harm to the environment or any outside energy inputs once installed. Designed for use at Fly Ranch, SkyWater is also portable and replicable. From the remote terrain along the U.S./Mexico border to refugee camps in Syria, Uganda, or Bangladesh to the pueblos hovenes of Lima or underserved neighborhoods in cities with aging infrastructure like Milwaukee, Pittsburgh, and Baltimore, it can be placed anywhere clean water is needed, no matter how humid or dry. SkyWater, without the need for intrusive, extractive, and expensive infrastructure, brings this precious and essential resource to all.

List of activities supported by SkyWater:

1. Non-extractive source of safe, pure, water. Pull up spigot shuts off automatically to prevent waste. Unit shuts off when tank is full or when temperatures dip below freezing. A solar powered bubbler keeps the water moving to prevent stagnation and/or ice formation in the tank and, as an extra precautionary measure, a UV light comes on for 3 minutes every hour to discourage bacterial growth.

2. Wayfinding. Ideally, each SkyWater unit would be installed so that it is visible from the next one but the lid, 3-D printed out of reusable resin, also provides a topographical map of the area that can be replaced with a new one should the unit need to be moved.

3. Communication/Information. Depending on the needs of the community, units can be equipped with a satellite phone/wifi hotspot or, if near one already, a repeater enabling users to tap into the internet from their own phones or other devices. Excess power generated by the solar panels and stored in the batteries can be made available to meet device charging needs.

Outputs:

1. Up to 9.5 liters of water per day per SkyWater unit.
2. Solar panels will generate approximately 2525 Watts per day some of which will be used to power the device while the rest will be stored in the batteries (capacity 7200 Watt hours) and available for use on cloudy days or for auxiliary purposes to be determined by the community.

Strategy for construction of prototype:

Because SkyWater is intended to be fully portable and to impact the site as little as possible beyond the delivery of water, it will be fabricated and pre-assembled in a controlled shop environment and then disassembled into pieces that can be transported to the site for installation by a small team. We will rehearse the reassembly prior to arrival on site to estimate time and power required. No individual item will weigh more than can be carried into sensitive areas on foot or, at most, on a small hand pulled cart. This will enable the team to work in a controlled environment to maximize production quality and protect technological components prior to their installation in the modular casings. The unit is designed so that all work on site can be accomplished using hand and/or battery powered tools and the team will bring their own back-up batteries and DC to DC solar charger if required. The only site work required will be the boring of the small diameter holes (using a battery powered hand auger) that will accept the pipes for the cane bolts necessary to prevent tipping and/or unauthorized removal of the SkyWater device. This assembly will also be pre-tested prior to arrival on site and can be modified to adapt to local conditions.

Estimated construction costs:

While many of the items used to construct the SkyWater are relatively inexpensive and readily available e.g. 8 fans at $25 each, 5 cane bolts at $150 each or even one food grade water tank for $500, others require a more significant investment like 4 lithium iron phosphate low- temperature-rated batteries at $1400 each. Custom fabricated items such as the insulated barrel housing of corrugated steel or the armature that supports the water producing panels will be expensive the first time they are made and the much cheaper in the future while some resources such as the solar panels with nanotechnological coating with sacred geometrical pattern or the hydrogel matrix and thermo-electric plate will require collaboration with companies such as Solaxes or ZeroMass. We have reached out to both of these companies at the same time that we have continued to look for other options and will pursue these connections further upon receipt of notification of selection as a finalist. It should be possible to produce a working model for approximately $25,000 with costs per unit expected to drop significantly going forward. Proof of concept would cost less but require elimination of some of the features that raise the unit from a utilitarian piece of hardware to a beautiful part of the landscape.

Sources:

Kallenberger, P.A., Fröba, M. Water harvesting from air with a hygroscopic salt in a hydrogel–derived matrix. Commun Chem 1, 28 (2018). https://doi.org/10.1038/s42004-018-0028-9

Mekonnen, M. M. & Hoekstra, A. Y. Four billion people facing severe water scarcity. Sci. Adv. 2, e1500323 (2016).

www.solaxes.ch

www.zeromasswater.com

Environmental Impact Statement:

The calculation of the lifecycle impact on the environment is essential for evaluating the success of any project. Materials have been chosen to achieve a balance between durability over time, the amount of carbon released into the atmosphere by their creation, and the degree to which they can be recycled should they need to be replaced. For example, while stainless steel (used in the shell and hardware) and glass (used in the solar panels) are created using high levels of energy, they are also highly durable and recyclable. The topographic map on the lid is 3-D printed using a weather proof and 100% recyclable resin making it easy to change out this feature if the device needs to be moved to another location. The commercially available and standard sized lithium ion phosphate batteries are completely and safely enclosed and designed for charging at temperatures down to -20 C. The water tank, also readily available commercially, is made of food grade BPA free high-density polyetheline (HDPE) designed to last for decades.

The presence of the object in the landscape is also of great concern. The leaf-like shape of the solar water collector is not only structurally stable due to it's curved shape but the use of a nanotechnological film coating allows the solar panels to be a completely opaque bronze color blending in with its surroundings no matter the season. The polished edges of the leaf reflect the sun, moon, and stars while a small amber light above the spigot allow users to access the device without spoiling their night vision or interfering with viewing of the stars.